KNOWLEDGE

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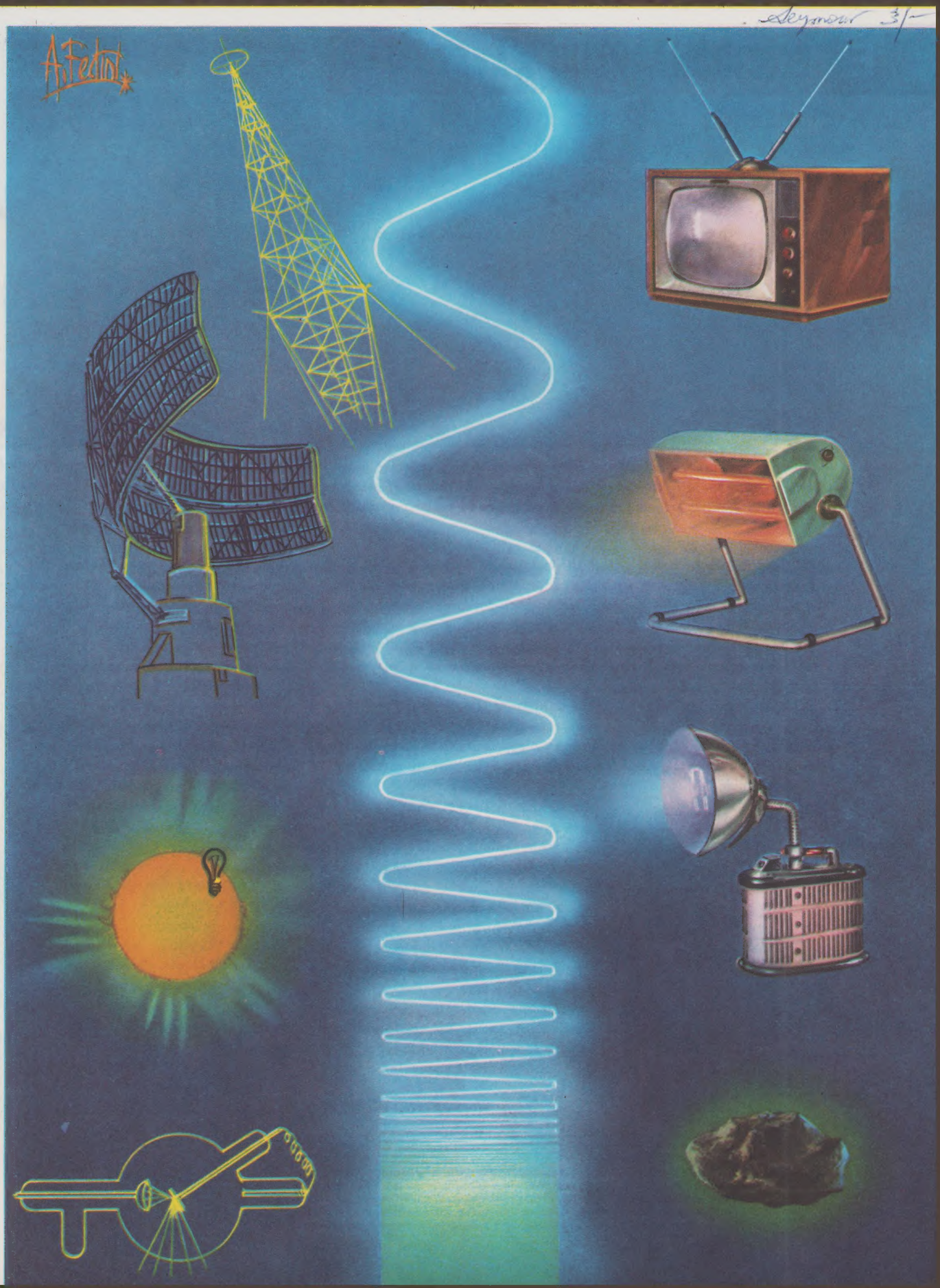

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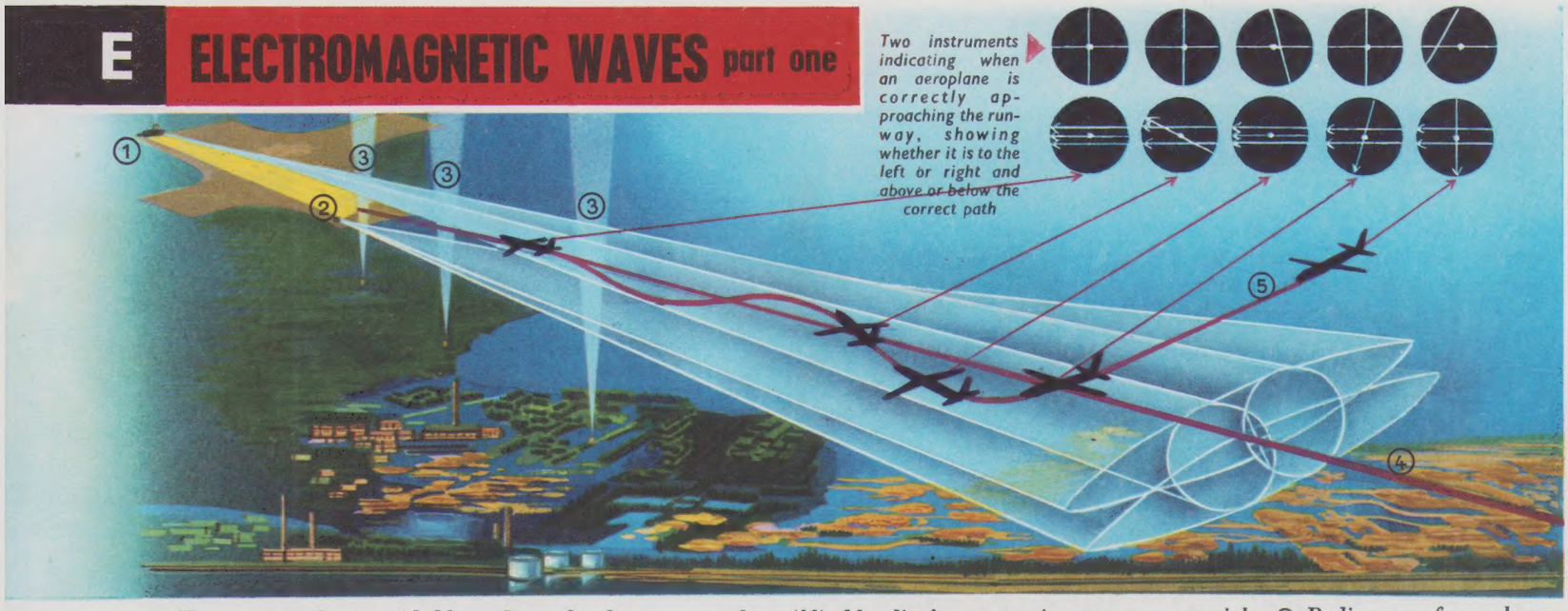
E ELECTROMAGNETIC WAVES part one


Two instruments indicating when an aeroplane is correctly approaching the runway, showing whether it is to the left or right and above or below the correct path
①
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How an aeroplane, guided by radio and radar waves, makes a 'blind landing' on to an airport runway at night. ① Radio waves from a beacon which define the direction the plane must take; ② pattern of waves which help to keep the plane at the correct altitude; ③ radio waves giving the distance from the end of the runway; ④ correct line of approach; ⑤ path of the aeroplane

IT is difficult to believe that the colours of a rainbow can be connected in any way with the radar signals that guide aircraft in to land; or that the X-rays used to look for broken bones can possibly be similar to the radio waves which bring the programmes to our wireless sets. Each is apparently so different from the other, yet all these four are connected in a very important way.

The radio waves, the radar, the light from the rainbow, and the X-rays are all examples of *electromagnetic waves*. Although they seem very unlike each other in many ways, scientists have found that they all obey the same laws of physics – they are all members of one family.

James Clerk Maxwell (1831–1879)

What are electromagnetic waves?

To understand the nature of these waves we must first think of another type of wave motion with which we are more familiar. Let us examine how sound waves are produced. When a tuning fork is struck it gives a musical note. The prongs of the fork oscillate to and fro and a layer of compressed air is formed in front of the moving prong. This compressed layer of air does not return to normal again when the prong moves back in the opposite direction. The air molecules move forward, and like a pendulum at the bottom of its swing they do not stop when the air reaches its normal state. The molecules fly on and collide with a new lot of air which is compressed and in turn expands. In this way a layer of compressed air travels outwards from the prong at the speed of sound. The individual air molecules oscillate to and fro over a short distance and do not travel with the wave.

Just as sound waves are caused by oscillating objects, electromagnetic waves are caused by oscillating electric charges. When an electron (a negatively charged particle) oscillates, or when it is speeded up (accelerated), or slowed down (decelerated), it causes magnetic and electric waves to be sent out. The waves can be likened to changes in magnetic and electric 'pressure' in space. As the waves pass this 'pressure' varies in a way similar to the gas pressure when a sound wave travels through the air.

However, there is a very important difference between sound waves and electromagnetic waves. Sound waves must travel through matter – solid, liquid, or gas – because they rely on the vibration of the molecules or atoms to transmit

Heinrich Rudolf Hertz (1857–1894)

Previous page: Electromagnetic waves are used by man in many different ways depending on the wavelength of the waves. From the top, left to right, are examples of instruments which receive or emit electromagnetic waves. The frequency of the waves they receive or emit increases the nearer the instrument is to the bottom of the page. They are: radio, television, radar, infra-red lamp, electric lamp, the sun, ultra-violet lamp, X-ray tube, and radium which emits gamma rays.

SHEEP AND GOATS

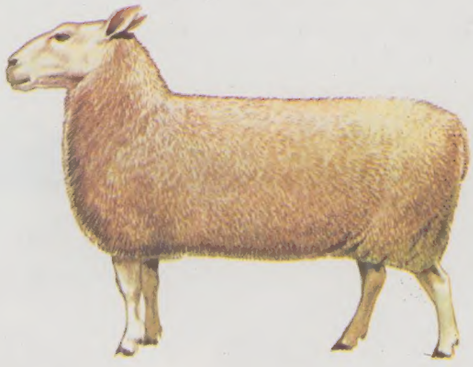
MEAT for the table, wool for the weaver, skins for coats, and milk for drinking and cheese-making; these are the benefits which sheep provide. No wonder that, apart from poultry, they are raised in greater numbers than any other domestic animal. By nature undemanding, they thrive both on the hot dry plains of western Australia and on the rain-soaked fells of the English Lake District. They can survive on pasture so sparse that a cow would starve, and many breeds can withstand the hardest winter with no more shelter than a stone wall.

Goats too are a source of meat, wool, skins, and in particular of milk. Indeed in many hot countries it is the goat rather than the cow which usually provides this. Even in cool climates herds of milking goats are not uncommon, though they usually belong to enthusiasts rather than to serious dairy farmers.

THE GOAT

A fine example of a male British Toggenburg goat

THE SHEEP



One of the world's best-known breeds of sheep, a Border Leicester ewe

CLASSIFICATION

Except in the case of certain long-haired breeds, sheep and goats are quite easily distinguished from each other. Nonetheless these two animals have much in common, for both are *ungulates*; that is, they have feet with cloven hooves, and both are *ruminants* or cud-chewing animals. Most goats have horns, though the horn-less breeds are often preferred. Some breeds of sheep have horns, some are hornless, and in some it is only the rams which have horns.

There are about 200 different breeds of sheep in the world. Though the external appearances of these breeds vary greatly, all sheep are probably members of the same species, *Ovis aries*. Goats are more diverse and probably represent several different species within the genus *Capra*.

From the zoological point of view sheep and goats are classified in the following way:

Class:	Mammalia
Order:	Artiodactyla
Family:	Bovidae
Genera:	Capra and Ovis

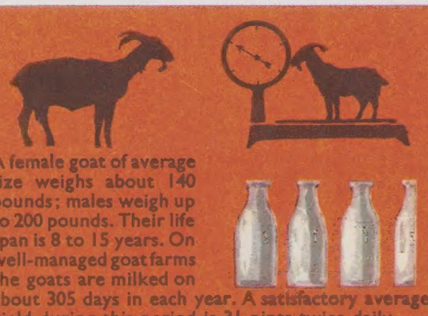
The earliest records of goats are Persian and it seems likely that the goats of the eastern species, *Capra aegagrus*, are the distant ancestors of many of the domestic breeds known today.

Goats, even the long-haired ones, may be distinguished from sheep by several characteristic features, one of which is the upwards curling of goats' tails. Besides this the males, or billy goats, of most breeds have beards, and also a characteristic goaty smell.

Female goats do not smell. They are gentle and intelligent creatures which often make excellent pets. Their kids are particularly attractive.

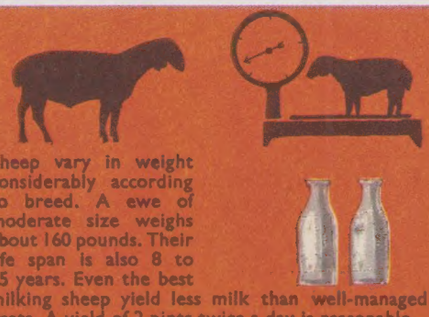
The origins of the many breeds of modern domestic sheep are uncertain. It is likely, however, that they are derived partly from the mouflon, *Ovis musimon*, and partly from the urial, *Ovis vignei*. The many diverse breeds now seen in different parts of the world are the result of hundreds of years of selective breeding.

In flat, dry, and sheltered regions it is usually possible to manage big flocks of the larger breeds. On rough upland pastures it is likely that lighter breeds will be more successful. Though size does to some extent determine the market value of sheep, the bodily conformation and the weight and quality of the fleece are also important.



A female goat of average size weighs about 140 pounds; males weigh up to 200 pounds. Their life span is 8 to 15 years. On well-managed goat farms the goats are milked on about 305 days in each year. A satisfactory average yield during this period is 3½ pints twice daily.

Goats' milk is often indistinguishable from that of cows. It is sometimes used to make an excellent milk cheese called Coulommier. But in parts of the world where cows can be milked successfully, the rearing and milking of goats is barely economic.



Sheep vary in weight considerably according to breed. A ewe of moderate size weighs about 160 pounds. Their life span is also 8 to 15 years. Even the best milking sheep yield less milk than well-managed goats. A yield of 2 pints twice a day is reasonable.

In the highly developed countries sheep are raised chiefly for their meat and for their wool. In south-east Europe and Asia, however, they are often kept for their milk. The delightful Roquefort cheese is made from the milk of sheep.

SOME BREEDS OF GOAT

Goats are particularly suitable for regions where the climate is hard or the country rough. They thrive well in cold and in heat, and also in the mountains. It is for these reasons that they are common stock animals in south-east Europe, Asia, and Africa.

EUROPEAN GOATS. Many European breeds are named after the country or the district in which they are most commonly found. But this does not mean that they are native to that area. Indeed, most of the modern European goats are descended in part at least from the two very famous Swiss breeds, the white Saanen and the brown-and-white Toggenburg.

ASIAN GOATS. The best-known Asian goats are world famous for the fineness and softness of their wool. One is the Angora which comes from Tibet and is often called the mohair. The other is the Cashmere, or shawl goat. The fine undergrowth in the fleece of this sheep is used to manufacture woollen garments of exquisite softness.

AFRICAN GOATS. Many of the goats in Africa are partly derived from the Nubian goats of Egypt. They vary in colour from white to black, and are easily recognised by their large lop ears.

Note: the illustrations on these pages are not all to the same scale.

FAMOUS BREEDS OF SHEEP

The existence of more than 200 different breeds is due partly to geographical barriers which have prevented the interbreeding of flocks from different regions, and partly to the skill of breeders who have intentionally crossbred and inbred their animals to produce stocks with particularly desirable characteristics. In consequence there are breeds best suited to all circumstances: for wool production and for mutton, for sheltered lowland pastures and for the rigours of life on northern hillsides.

BRITISH SHEEP. Britain is the home of many of the world's most famous breeds of sheep; the names Leicester, Cheviot, Romney, Lincoln, and many more are familiar in sheep-rearing circles throughout the world. Besides these, however, there are many less well-known breeds: the Swaledale, the hardy little Herdwick of the Lake District, and many others.

Lincoln ewe

Dorset ram

Cheviot ram

Texel ewe

Suffolk ram

Corriedale ram

THE MERINO. Merino sheep came originally from Spain. The fleece of an adult weighs about 12 pounds and is heavier than that of any other breed. Merino sheep are raised in large numbers in Australia.

KARAKUL SHEEP. These are a Middle-Eastern breed. They provide meat, milk, wool, and skins. The skins of new-born Karakul lambs are familiar to many Europeans as Persian lamb fur coats.

Merino ram

Karakul ewe

Karakul lamb

KEIR HARDIE AND THE LABOUR PARTY

A newspaper illustration of the great dock strike of 1889 *– help for this strike poured in from all over the world*

THIS article will be more about the Labour Party than about Keir Hardie. For he was not a great man in the usual sense of the word. He did not change the course of events, but his vigour and sense of purpose enabled him to lead and direct one of the most decisive movements of modern British history – the growth of the working class as a political force.

Today we take it for granted that there are two main political parties, Conservative and Labour. But at the beginning of this century there was no such thing as the Labour Party. In 1900 the dominant parties were the Conservatives and Liberals. The Conservatives were 'reactionary'; the Liberals were 'progressive'. There were, of course, a few Members of Parliament who were more progressive than the Liberals. They usually called themselves Radicals, but always voted with the Liberals. Most people considered the Liberals the party of the working man. But it was not a party of working *men*. Like the Conservatives, its leaders were upper-class men like Lord Rosebery or Henry Campbell-Bannerman. Such men were the traditional rulers of Britain, and since in those days M P s received no salaries they were the only ones who could *afford* to go into politics.

The rise of the working class

The workers had been given the vote in the great Reform Bills of 1867 and 1884. The first was passed at a time when only one section of the workers were really discontented – the manual workers. For the Trade Unions had developed into powerful organisations for bargaining for better conditions. And the Union movement consisted only of skilled crafts whose proud members were in a better position to bargain than their unskilled brothers.

But after 1867 a new spirit was in the air. In that year the London Working Men's Association resolved to try to get working men into Parliament. The government instituted education for all in 1870; between 1871 and 1876 the Trade Unions were given improved legal status; in the 1880s unskilled unions began to be formed. Above all a great depression in the 1880s caused dire hardship. Even the skilled workers were no longer well-off and a united front of all the working classes was forming against the employers. When the dockers called their momentous strike in 1889 help poured in not only from British workers but from all over the world.

Thus there existed side by side two different views; one was traditional – that labour should be concerned only with the organisation of industry and that the Trade Unions were the vehicles for this. The other was the growing feeling (which was shared by many 'unskilled' unionists) that labour must be represented in Parliament. In 1892 eight candidates, independent of all parties, stood for election. Two of them, including Keir Hardie, were elected.

Labour in Parliament

Keir Hardie was very much a working-class man. He was born in 1856, the eldest of a family of nine. He grew up in indescribable poverty in a one-roomed house near Holytown in Lanarkshire. Almost always cold, hungry, and over-worked, he was an errand boy in Glasgow before he went down the mines at the age of ten. He grew up with a resilient and independent spirit, and young Hardie wanted to do something to improve the lot of unfortunates like himself. In 1886 he became secretary of the Ayrshire Miners' Union and the following year he started a paper, *The Miner*. He became a prominent member of the newly formed Scottish Labour Party and in 1892 stood for West Ham South. As we have seen, he was elected.

His arrival in the House was a sensation. Far from hiding his humble origins he paraded them. He entered the House in a cloth cap to the accompaniment of a loud blast of a cornet which heralded symbolically the coming of a new era. In 1893 Hardie was largely responsible for the formation of the socialist Independent Labour Party. He was its first chairman and also present at its first meeting were Tom Mann and Ben Tillett from the unions (who had played a large part in the dock strike) and Bernard Shaw who represented the socialist Fabian Society.

In Parliament Hardie became a kind of one-man party, loudly speaking out for working-class rights, votes for women, and Home Rule for Ireland. He lost his seat in 1895 but the following year

was elected for Merthyr which continued to elect him for the rest of his life.

Hardie's ceaseless activity in the socialist cause did much to create a new body of working-class opinion. In 1899 he wrote a major article, in collaboration with Ramsay MacDonald, for the *19th Century* in which he denounced co-operation with the Liberals. 'Liberalism,' he declared, 'occupying itself with the successful businessman's standpoint, had generally assumed that the man politically enfranchised would be economically free; but experience was proving that that hope was thoroughly false, and Liberalism had nothing to put in its place.'

The article was of great significance. In particular it impressed the Trade Unions who were hostile to Parliament's prohibition of large-scale picketing. The T U C called a special conference 'to devise means of increasing the number of labour members'. From that conference (February 1900), which founded the Labour Representation Committee, dates the real beginning of the Labour Party.

Those unions (and there were not many) who joined that Committee had to contribute to a fund for the upkeep of Labour M P s. Yet it was far from a rich body. In 1900 (when Keir Hardie went to the House of Commons with only one Committee colleague) the total election expenditure of the Committee was £33.

The rise of the Party

What transformed the situation was the Taff Vale Judgment. The High Court and the House of Lords held that the Amalgamated Society of Railway Servants was responsible for damages incurred during a strike. This shocked all the Trade Unions who realised that strike action itself was threatened. Many of them were rapidly won over to the Committee. At the general election of 1906, 29 Labour candidates were elected. The Liberals altered the Taff Vale Judgment – and the L R C changed its name to the Parliamentary Labour Party. Keir Hardie was elected its first chairman.

As yet the miners' unions did not join this new party. They were so strong in certain areas that they were able to elect their own candidates who were officially members of the Liberal Party – 'Lib-Labs', as they were called. In 1910 the miners did join the Labour Party and its M P s now numbered 42. The solidarity of the Labour Party and the Trade Unions was now virtually complete and has remained so ever since.

Two things hampered the Labour Party from the beginning. First, there did not seem to be much difference between them and the Liberals. Even the fundamental difference between *socialism* (that the State should legislate on a wide scale in social questions) and *laissez-faire* (let well alone) *liberalism* was obscured; for the Liberals *did* legislate in social questions; and the Labour Party was the party of *labour*, whether socialist or not, and included many non-socialists. Thus while the Liberals were strong, Labour was weak; but after the Asquith-Lloyd George split ruined the Liberals (see page 2382) Labour was ready to step in.

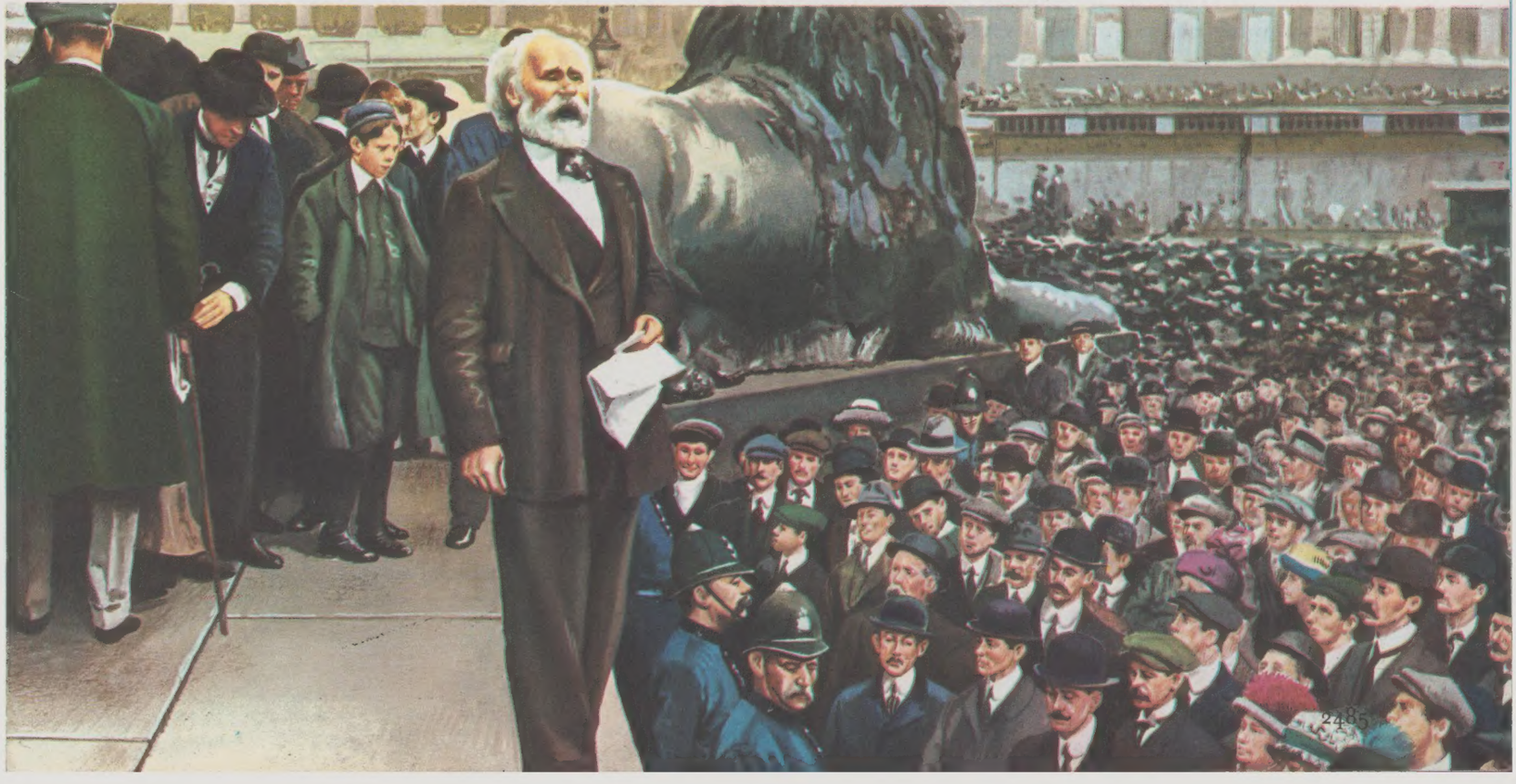
The second ever-present difficulty for the Labour Party was finance. They secured a great victory when the Liberals introduced payment for M P s. But the whole question of Labour finance was shaken by the Osborne Judgment in 1909. Osborne, a union official, took his case against paying the political levy to court. And won it. There was an outcry – for the very existence of the Party was threatened. For four years things hung in the balance. Then in 1913 a new judgment was delivered: that all unionists must pay the levy unless they specifically 'contracted out' of doing so – which few had the courage to do.

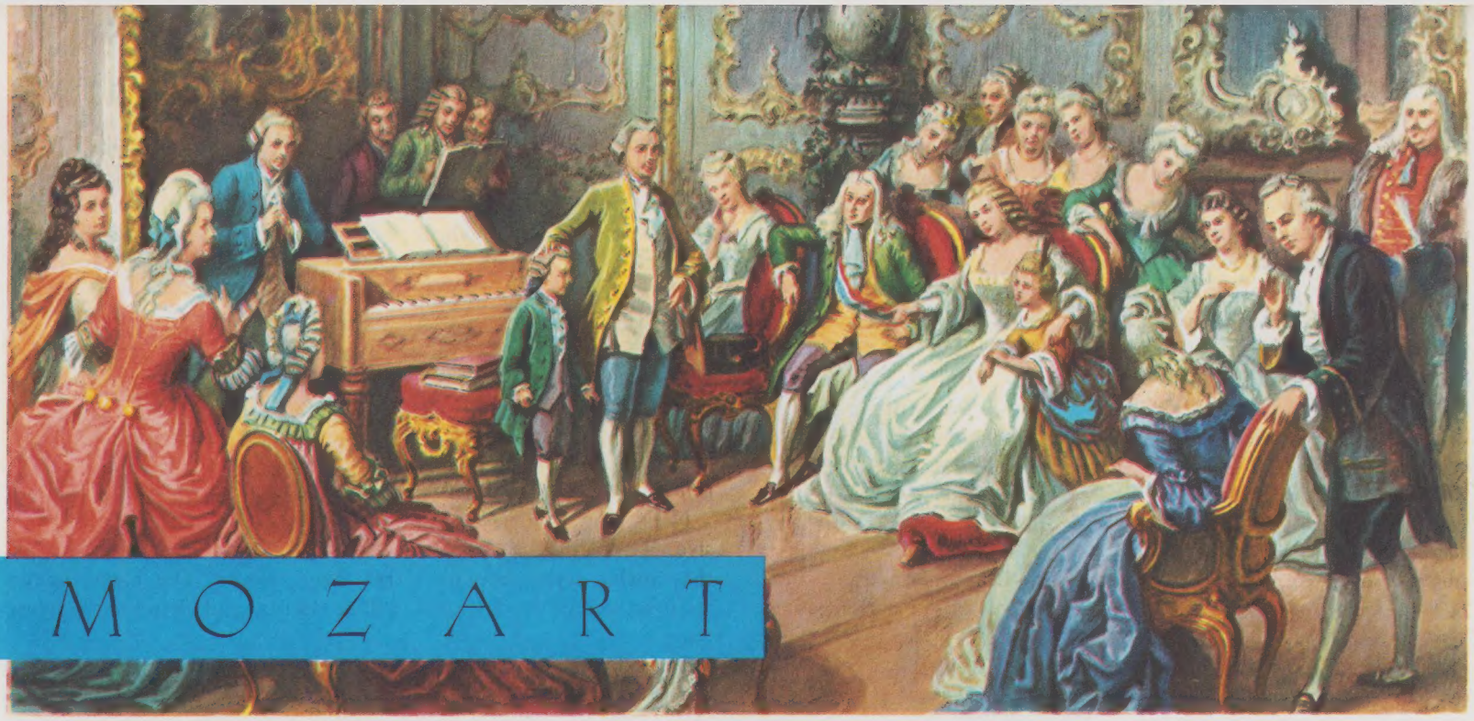
The First World War was a grave disappointment for Keir Hardie. He believed that the Marxist *International* of working men could prevent a war breaking out by calling massive and simultaneous strikes. His never-too-strong health gave way under the anxieties of war and he died on 26th September 1915. But the Labour Party did not die, and went from strength to strength. Shortly after the end of the war, in 1924, Ramsay MacDonald became the first ever Labour Prime Minister of Great Britain.

YOU SHOULD NOW KNOW

1. *When was the Independent Labour Party founded?*
2. *What is a political levy?*
3. *Who won the Taff Vale case?*
4. *What happened at the Osborne Judgment?*
5. *How many Labour M P s were there after the 1906 election?*

Keir Hardie harangues a meeting in Trafalgar Square in support of votes for women





MOZART

The young Mozart at the court of the Empress Maria Theresa. His brilliance as a composer and performer brought him international acclaim

THE early success of Wolfgang Amadeus Mozart was meteoric. At the age of three he was sharing his sister's music lessons; by the time he was eight he had written keyboard music, violin sonatas, and a symphony. By the age of 17 he had written about 29 symphonies, 8 operas and operettas, church music, keyboard music, and chamber music. But unlike so many infant prodigies, Mozart's exceptional gifts did not burn themselves out. Instead his compositions increased immeasurably in technical skill and depth of feeling, so that in spite of his early death he ranks today as one of the greatest composers that has ever lived.

Early eminence

Mozart was born in Salzburg in Austria on 27th January 1756, the only surviving son of Leopold Mozart who was himself a gifted violinist. His first lessons were given to him by his father; and the child's rapid progress, both at the keyboard and as an extraordinarily precocious composer, convinced Leopold that a tour 'showing off' his prodigy would be profitable in every sense of the word. Accordingly between 1762 and 1766 young Mozart performed in Munich, Vienna, Stuttgart, Cologne, Brussels, Paris, and London. He was a sensation. People flocked to hear him. Parents began to parade their own child prodigies – one claiming to be a better organist at three than Mozart had been at the same age!

On his return to Salzburg Wolfgang became *Konzertmeister* to the Archbishop – an honorary appointment which did not prevent his father taking him to Italy – the 'home' of 18th-century music. Here too he was acclaimed, and his new opera *Mithridates* was performed at the Scala, Milan – a fantastic achievement for a child of 14.

When Mozart returned once more to Salzburg he faced the problem of all infant prodigies – that of making an adequate living as an adult. No longer in great demand as a performer, he started to compose in earnest; but the new Archbishop of Salzburg was a hard master and demanded a great deal of church music for a very small salary. A tour to Paris in 1777 proved unsuccessful, and on his return the overbearing attitude of the Archbishop led to constant bickerings and, inevitably, to Mozart's resignation.

In 1782 he finally settled in Vienna and married Constanze Weber; the marriage was a happy though impecunious one. The productions of *Idomeneo*, *The Marriage of Figaro*, and *Don Giovanni* established him as a great operatic composer, but brought him little financial reward.

Mozart had many friends in Vienna, among them the composer Joseph Haydn who declared him the greatest composer he had ever met or heard of. But although some of Mozart's friends were rich, even royal, he himself remained poor. Out of sheer necessity he was driven to a frenzy of composition. Operas, symphonies, Masses, and concertos, flowed from his fluent pen with astonishing rapidity – but alas! at the expense of his health.

In July 1791 a mysterious stranger commissioned him to write a *Requiem Mass*, paying him handsomely in advance. This had a depressing effect on Mozart, whose health, through anxieties and overwork, had broken down. He became convinced that his own death was not far off, and not even the successful reception of his brilliant opera *The Magic Flute* could shake him out of his deep melancholy.

The end came on 5th December 1791. His cheap plain coffin was carried by a few friends through the streets of Vienna in a blinding snowstorm and laid to rest in a pauper's grave. When his wife tried to identify the grave years later, all trace of it had gone.

Always elegant

Today Mozart is revered as one of the greatest of composers. Not only that, but his works are astonishingly easy to like, and few days go by without something by Mozart being broadcast. Gay, tuneful, and utterly charming, symphonies like the 'Haffner' (No. 35), the 'Prague' (No. 38), and his last, the 'Jupiter' (No. 41), delight audiences today as they have done since his own day. He was incapable of producing anything unpolished or lacking in elegance, whether it was a simple sonata, a quartet, or a large-scale opera. And with all his polish he often reaches greater depths than the more turbulent romantics who followed, who are often considered more profound. His G minor symphony (No. 40) is a masterpiece, and through the superficial ease of many of his works one can detect a truly magnificent musical soul struggling to find expression.

ENGLISH MEDIAEVAL CATHEDRALS

A CATHEDRAL is any church which contains the throne (or *cathedra*) of a bishop. It was so in the Middle Ages, and it is now. But then cathedrals were far more than simply centres of religion – they were also centres of cultural and educational life and even of protection. For mediaeval cathedrals housed the greatest art galleries and libraries, and were the finest concert halls in the country. And their massive stone structures provided sanctuary for those who were 'on the run', while in times of national peril people would shelter behind their impregnable walls.

In the Middle Ages a cathedral was very much more than a large church. It was the headquarters of ecclesiastics who were among the greatest men in the land – like Langton, Lanfranc, and Becket. During this Age of Faith the resources of the nation went into glorifying God. This was done discriminatingly, however, and while parish priests were often poor and illiterate, the cathedrals were centres for all the most educated and brilliant scholars; and the revenues from their vast estates were enormous. It is hardly surprising that the cathedrals are synonymous with 'English mediaeval architecture'. They embodied its greatest triumphs and highest aspirations.

The first English cathedral was Canterbury, which has remained a shrine in England since St Augustine converted the king of Kent. In time Christianity extended throughout the land (see page 150). The first dioceses were naturally centred on the most important town within each English kingdom and the diocesan boundaries corresponded to the boundaries of that kingdom.

The Age of Faith lasted for centuries; and throughout those centuries the cathedrals were lovingly tended. And as throughout those centuries architectural fashions changed, most English cathedrals show a succession of different styles; for styles would often change before a cathedral was finished or during the tenure of a progressively minded bishop. English cathedrals did not simply reflect continental fashions although they were closely related; among the many differences is the one special English characteristic – the cathedral close.

The Age of Faith lasted long, but not for ever: the Reformation did not alter people's devoutness but it did (together with the Renaissance) alter their sense of proportion. Men began to spend money on palaces, houses, and colleges which rivalled and then supplanted cathedrals as the best examples of English architecture.

FOUR GREAT STYLES

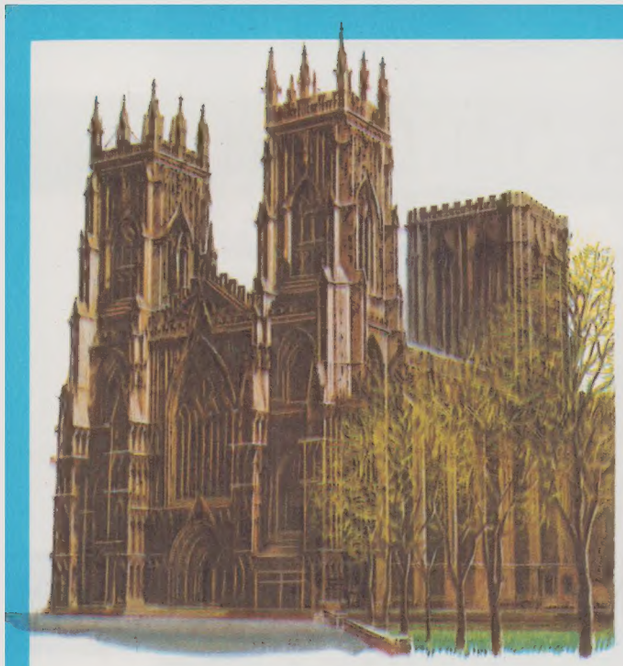
English mediaeval architecture produced four great styles (one Norman and three Gothic). *Norman* lasted from approximately 1050 to 1150; *Early English* to 1250; *Decorated* to 1350; and *Perpendicular* to 1450. Between each style there were *transitional* styles, the most remarkable being that between Norman and Early English.

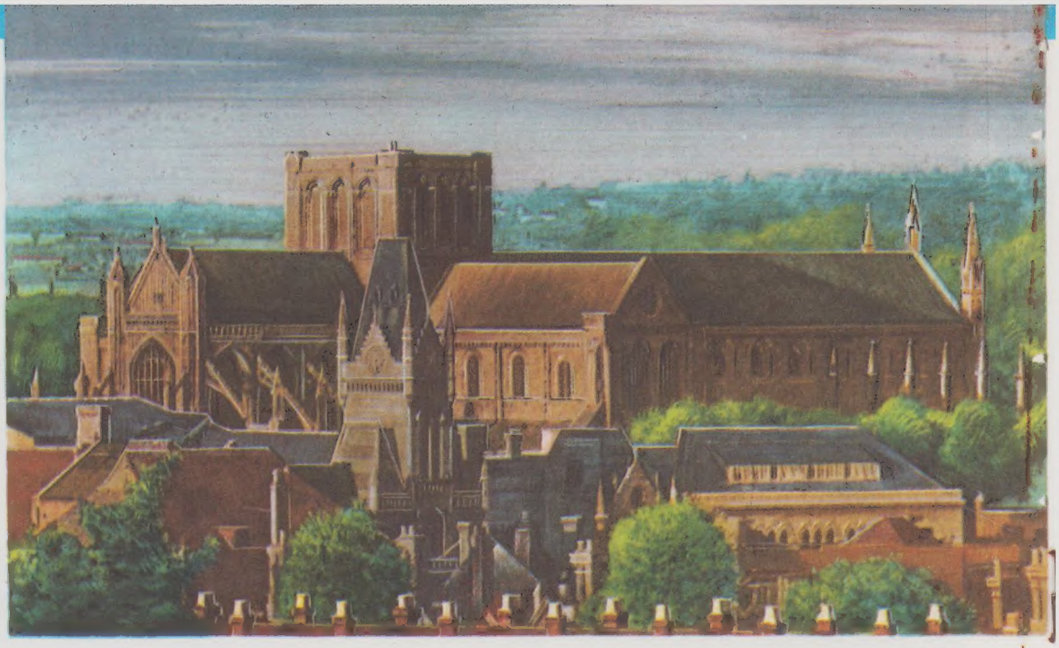
Norman (or English Romanesque) architecture was bold and massive, featuring rounded arches, heavy piers, and flat buttresses. But the Gothic styles became increasingly refined. The main Gothic features are pointed arches, ribbed vaults, and flying buttresses. Pointed arches overcame the difficulty of vaulting oblong areas; and beautiful 'patterned' vaulting (ribbed vaulting) is characteristic of Gothic architecture. The weight of stone vaults high above the lofty Gothic naves exerted a considerable thrust outwards. This was received by the flying buttresses and pinnacles on the outside, which took the weight straight down to the ground away from (and so by-passing) the walls. One result was that walls no longer had to act as supports; instead they could be filled with lovely glass windows.

In the Early English style the ornamentation was simple and the outlines were well defined. The Decorated (or Geometrical) style is marked by its ornate flowing tracery and elaborately carved capitals. The Perpendicular style replaced these flowing lines with upright and rectangular shapes, in windows, panels and decoration.

As we have said, English cathedrals grew up in the Age of Faith. But subsequent centuries did not prove so fertile for their development. Most of the cathedrals suffered terribly during the Puritan regime of Cromwell when Roundhead fanatics stripped them bare of their priceless but 'idolatrous' treasures. But when the softer climate of the 19th century caused a desire to restore those cathedrals which were in decay, the work was often done with clumsiness and lack of taste. Nevertheless no visitor to England would leave without taking with him a memory of England's greatest heritage – her cathedrals. And no Englishman would be without them.

CANTERBURY; *Cathedral of Christ Church.* Ever since King Ethelbert of Kent was converted by St Augustine Canterbury has been the seat of the Primate of England. The first cathedral, founded in 601, was destroyed soon after the Norman Conquest. Archbishops Lanfranc and Anselm built a new cathedral, the eastern end of which was gutted by fire in 1174; parts of this church still remain, however, in the beautiful crypt. The great Norman architect William of Sens began the reconstruction; four years later he was disabled by a fall from the scaffolding and the work was continued by William the Englishman who completed it in 1184. After the murder of Thomas Becket in the north-west transept of the cathedral in 1170, his shrine became the most popular English pilgrimage place of the Middle Ages. Between 1379 and 1400 the nave was rebuilt in Perpendicular style; the west front was completed in about 1440, but the north tower is a 19th-century replica. Between 1495 and 1503 the lovely central tower 'Bell Harry' was raised to replace the Norman 'Angel Steeple'.

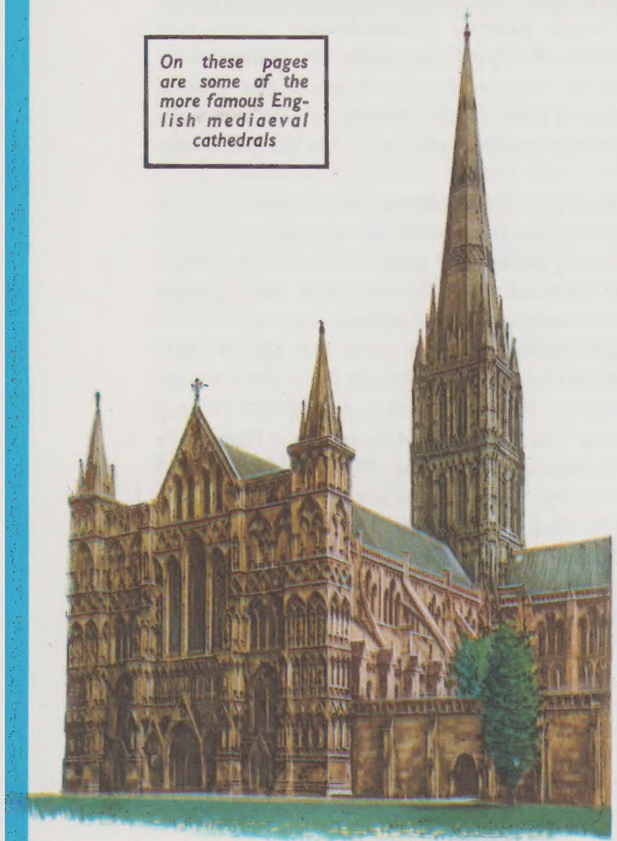




On these pages are some of the more famous English mediaeval cathedrals

YORK; *Cathedral Church of St Peter.* York, the seat of the second archbishop of England, is the largest in area and width of any English mediaeval cathedral. The first church on the site was wooden, erected in 627 for the baptism of Edwin of Northumbria by Paulinus, the first archbishop. The stone building begun shortly afterwards was destroyed by the Norman invaders, but another was completed by 1200. This was rebuilt between 1227 and 1472. York has retained much of its original glass, including the exquisite Five Sisters window.

WINCHESTER; *Cathedral Church of the Holy and Indivisible Trinity.* Winchester, the longest Gothic cathedral in Europe (560 feet) and shrine of St Swithin, was begun by Bishop Walkelyn under William the Conqueror on the site of a Saxon cathedral. The transepts and tower are still Norman, but the nave and choir were transformed by Bishop Edington and the famous William of Wykeham (1367–1404). The great Norman piers were recased with stone in Perpendicular style, the triforium removed, and a vaulted roof built concealing the Norman timber one.

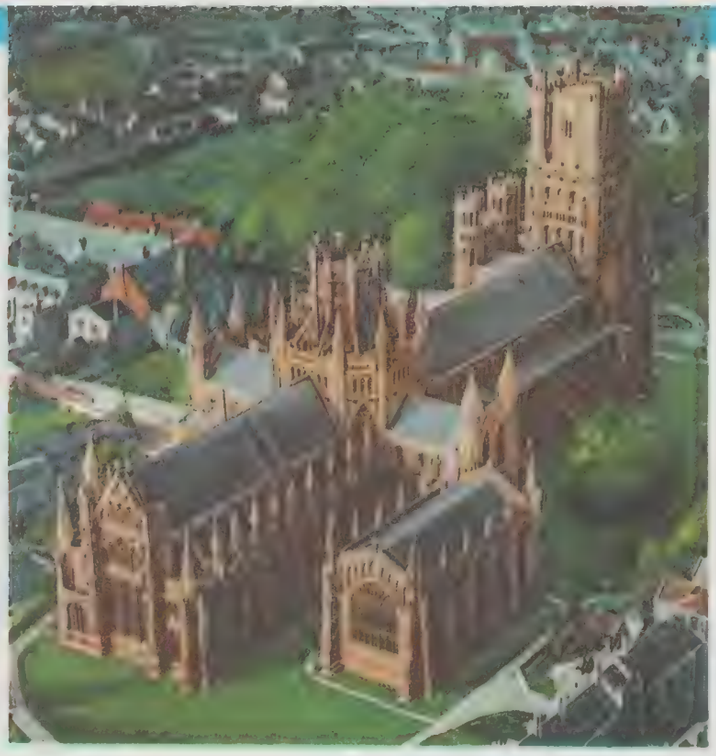


SALISBURY; *Cathedral Church of St Mary.* Salisbury Cathedral, in its beautiful close, is the purest and most perfect example of the Gothic style in England. Begun in 1200 and consecrated in 1250, it is unique among English cathedrals in being almost entirely all of one style – Early English. Its finest feature is the 14th-century octagonal spire, at 404 feet the highest in England and held by many to be the most beautiful in Europe. The Decorated cloisters are among the largest and most impressive in England.

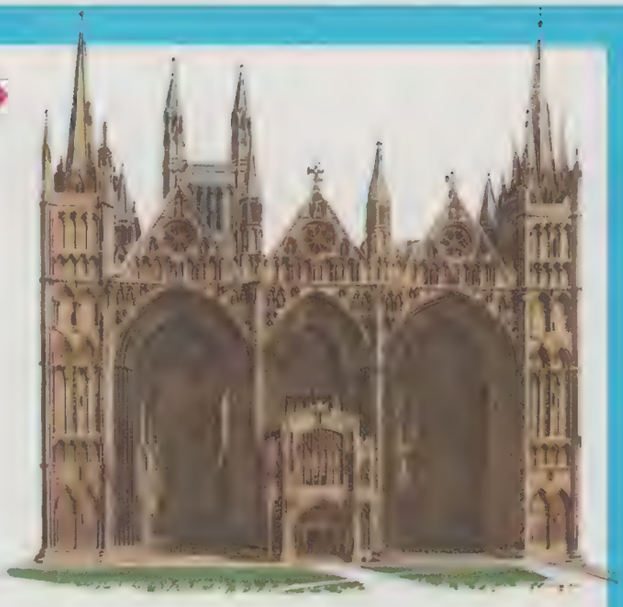
GLOUCESTER; *Cathedral Church of the Holy and Indivisible Trinity.* The present cathedral was begun in 1089 and consecrated in 1100; the nave with its massive pillars is still Norman. In the 14th century Gloucester became rich from offerings at the shrine of Edward II who was murdered at Berkeley Castle in 1327, and the choir and transepts were overlaid in the then revolutionary Perpendicular style. The rich vaults of the choir and cloisters are among the finest in the country. The building is dominated by the late Perpendicular central tower, 225 feet high.

DURHAM; *Cathedral Church of Christ and the Blessed Virgin Mary.* Durham Cathedral, rising majestically above the wooded cliffs of the river Wear, is the most dignified of all the English cathedrals. Enshrining the bones of St Cuthbert and Bede, it has long been a place of pilgrimage. Begun in about 1096 and completed in 1133, the Norman nave with its enormous spiralled and fluted pillars is one of the finest in Europe. Beyond the choir is the famous 13th-century chapel of the Nine Altars.

WORCESTER; *Cathedral Church of Christ and the Blessed Mary the Virgin.* Worcester, which contains the shrine of St Wulfstan and tomb of King John, provides an impressive record of church building in England right from early Norman to Tudor times. The crypt, transepts, chapter house, and part of the nave are Norman; the Lady Chapel and choir Early English; the rest of the nave, the cloisters, and the central tower Decorated and Perpendicular; while Arthur's Chancery (commemorating Henry VIII's eldest son) is Tudor.

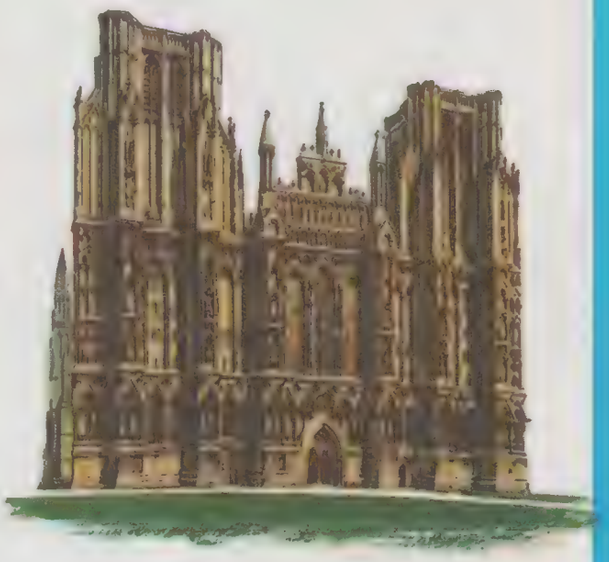


PETERBOROUGH; *Cathedral Church of St Peter*. The first church of Peterborough had a stormy history – sacked by the Danes, pillaged by Hereward the Wake, and gutted by fire. The present building was begun in 1118 and the major part, including the interesting timber roof, is still Norman, the nave almost as fine as Durham. The glory of Peterborough is the lovely Early English west front with its three soaring arches. The New Building erected around the original Norman apse has a beautiful fan vault.



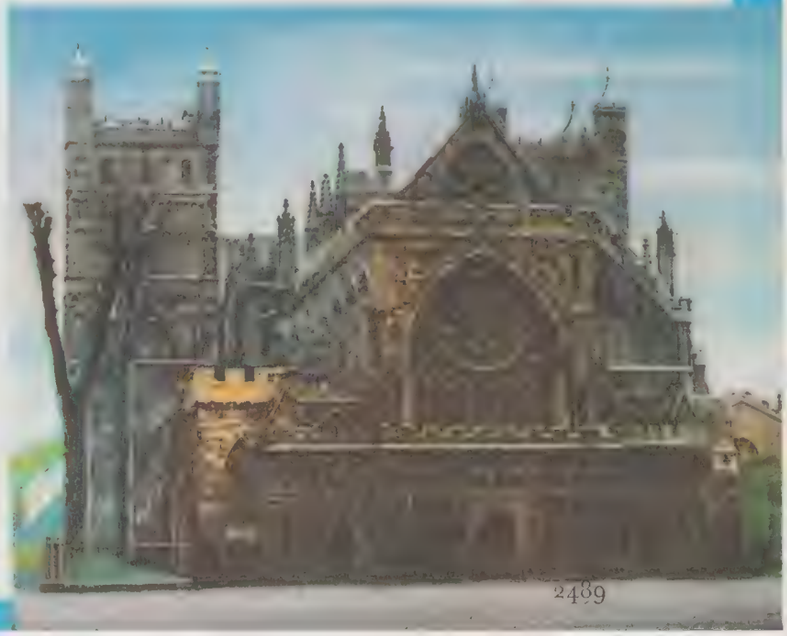
ELY; *Cathedral Church of the Holy and Undivided Trinity*. Ely, on a once desolate island in the Fens, rivals Peterborough in the drama of its early history; and, like it, its nave is still Norman with a timber roof. In 1322 the Norman central tower collapsed and was replaced by an octagonal lantern tower, the building of which was one of the most daring mediaeval architectural constructions. Ely is one of the most spacious cathedrals and famous for its carving.

WELLS; *Cathedral Church of St Andrew*. Wells is one of the smallest English cathedrals, and on account of its incomparable west front also one of the most beautiful. It is mainly Early English in style, and the lovely central tower is supported by curious inverted arches. The great sculptured screen, extending right across the west front, displays the most remarkable array of mediaeval figure sculpture in England. Wells is also famous for its exquisite Lady Chapel (1326).



LICHFIELD; *Cathedral Church of St Mary*. Lichfield, built of attractive red stone and with its three graceful towers – 'the ladies of the vale' – must once have been among the most beautiful English cathedrals. Unfortunately it has suffered terribly at the hands of both Civil War soldiers and 19th-century restorers. Nonetheless its beautiful nave is one of the most perfect examples of Early Decorated work.

EXETER; *Cathedral Church of St Peter*. Begun in the late 13th century, and completed 100 years later, Exeter is the finest specimen of the Late Decorated style. Its unique twin towers over the north and south transepts, its remarkably symmetrical plan, and its perfect proportions give it a tremendous unity. Exeter was one of the most sumptuous cathedrals and is still exceptionally rich in carved wood and stone work.



RESPIRATION (part one)

WHEN people sit quietly, the rate at which they breathe steadily decreases until it is just sufficient to provide the amount of oxygen that their bodies need at rest. This respiration rate *at rest* varies considerably with age, and is much higher in young people than it is in adults. In newborn babies it is usually between 30 and 40 breaths per minute, but as children grow up the rate slows until in adult life it is only about 16 per minute in males, and about 18 per minute in females.

VITAL CAPACITY

If, after drawing the largest possible breath, a man breathes out as deeply as possible, the volume of air expired represents the greatest volume that the lungs can exchange. This volume, the *vital capacity*, is usually 3 to 5 litres.

SPIROMETRY IS THE NAME GIVEN TO THE MEASUREMENT OF RESPIRATION VOLUMES

NORMAL RESPIRATION

The air which is breathed in and out with each respiration is called the *tidal air*. In an adult breathing quietly and at rest its volume is usually between 350 and 500 millilitres. About 150 millilitres of this air, however, merely occupy the respiratory passages and do not reach the lungs.

FORCED RESPIRATION

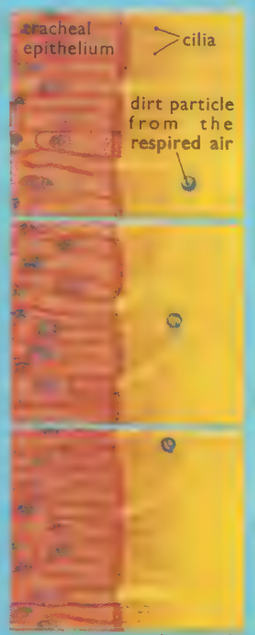
If, at the end of a normal expiration, a man breathes in as deeply as possible, the amount of air that he can draw into his lungs is about 3,500 millilitres. This volume is seven times greater than the volume of a normal quiet inspiration.

Alternatively, if at the end of a normal expiration he makes an effort to expel as much as possible of the air which normally remains in his lungs, he can breathe out about 1,000 millilitres.

HOW THE AIR WE BREATHE IS CLEANED

During the course of his lifetime the total volume of air that a man breathes is very large indeed, and, as it contains many small particles, the amount of solid material which enters his respiratory system is quite considerable. Fortunately the body is able to dispose of this material in a very efficient way.

Large particles catch on the hairs in the nostrils or stick to the mucus in the nasal cavities. They are disposed of when the nose is blown. Smaller particles which manage to find their way into the trachea often stick to the mucous membrane there. As the cells in this region are provided with *cilia* which constantly waft in an upward direction, the particles are slowly moved towards the pharynx. Here, entangled in mucus, they are swallowed and so no longer endanger the efficiency of respiration.



How cilia move dirt to the pharynx

OXYGEN

Just a little less than four-fifths of the air that we breathe consists of the gas nitrogen which plays no active part in respiration. The remaining fifth is almost all oxygen. This is the gas which the lungs extract from the air and transfer to the blood. The efficiency with which the lungs do this is such that the oxygen content of the inspired air, 21 per cent, is reduced in the expired air to 16 per cent. Thus for every resting breath of 500 millilitres of air, approximately 25 millilitres of oxygen are absorbed into the blood. In its place there appears an approximately equal amount of carbon dioxide, which, unwanted and poisonous in the body, passes from the blood into the expired air.

NAPOLEON'S EUROPE 1800–1810

Napoleon Bonaparte – greatest conqueror since Charlemagne

IT had been a dangerous voyage, but the young general had made it. He had slipped through the British fleet which had had strict orders to prevent him escaping from Egypt. Once, a detachment of British ships had stopped the craft on which he was making his flight, and a perilous chase ended only with nightfall saving the fugitive. And now he was home, to a tumultuous welcome. People lined the streets of the ports, towns, and villages through which he passed as he made his way to Paris. For here was a conqueror, a hero, a man who had once beaten the Austrians in Italy and recently led French troops into mysterious, exotic Egypt where '40 centuries looked down' from the pyramids upon his soldiers. Frenchmen needed something to shout about – someone to idolise. For things had been going badly. French armies had been defeated by the Austrians in Italy, while England's implacable enmity seemed certain to result in the loss of Belgium – that first prize of the wars of 1792. It seemed as if France's efforts to achieve her 'natural frontiers' were doomed to failure. Meanwhile the government was proving incompetent and unpopular. The cumbersome Directory was on its last legs; the people were underfed and underpaid; they were sick of war; they suspected corruption.

It would have been surprising if that young general who was so obviously and extravagantly welcomed by the people had not hoped to have a big say in the future affairs of France. Because he was Napoleon Bonaparte, who felt himself to be a man of destiny, he may have imagined even more. Yet even he could scarcely have dreamed that within 10 years he would be Emperor of France, arbiter of Europe, and able to place his relatives at will upon many of the important thrones of Europe. How traditional Europe became Napoleon's Europe in so short a space of time is one of the most amazing stories history has to tell.

CODE CIVIL.

OU

RECUEIL DES LOIS

Sur les Droits civils, — le Mariage, — le Divorce, — l'Adoption, — la Tutelle, — la Puissance paternelle, — les Successions, — les Donations, — les Testamens et Legs;

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PAR LE CORPS LEGISLATIF,

depuis le 18 ventôse jusqu'au 30 floréal an XI.

A PARIS,

Chez Marcand, Libraire, Palais du Tribunat première galerie de bois, près le passage de Valois, n° 188 et, passage Feydeau, n° 22.

M. DCCC. III

The title page of the Code Napoléon (1803 *edition*)

18th Brumaire

When Napoleon reached Paris he found men only too willing to co-operate with him to overthrow the Directory. In particular there was Siéyès, an ageing politician who imagined he could use Napoleon's glamour and power with the army to give him (Siéyès) real leadership of France. He planned to ignore those of the five Directors he could not trust and to get the two constitutional councils, the Council of Elders and the Council of 500, out of Paris to St Cloud. There Napoleon's troops would terrorise them into accepting the new constitution, which would place all power in the hands of three Consuls: Siéyès, his fellow director and personal protégé, Ducos, and Napoleon (whom Siéyès thought could be fobbed off with unimportant offices). The fateful day on which placards and posters were to announce the revolution, and the councils were to vote in the Consuls, was the 8th November; or, as it was known on the French calendar, 18th Brumaire.

That day did not go well. Napoleon made a dreadful speech and the councils were hostile and suspicious of his dictatorial ambitions. It was Napoleon's brother Lucien, President of the Council of 500, who saved the day by his cool courage and daring. Holding a sword to his shaken brother's breast, he swore to kill him if he should ever subvert French liberties. Meanwhile the soldiers, incensed at a wound their hero had received (Napoleon was bleeding on the face but in fact had only scratched himself in his anxiety), rallied to him. Anyway, by the evening the Consuls were in power.

Napoleon lost no time in having himself proclaimed First Consul, which meant that he would have virtually total power. The others could not resist – after all, Napoleon controlled the army. His position as First Consul was strong but not indestructible. Like all would-be dictators, he needed success. If he was successful then he would maintain and even extend his authority. If not, there were plenty of able men waiting in the wings to take over. Thus Napoleon had to prove himself a great ruler so that he would be allowed to rule. And he did prove himself a great ruler.

The movements of the armies in the campaign of Marengo

The battle of Austerlitz – Napoleon (on the white horse)

His energy was astonishing. He was never still. He was constantly attended by one or more secretaries to whom he incessantly dictated orders, letters, and requests.

The result of his prodigious labours was that French administration improved out of all recognition. His famous Codes provided a uniform judicial system, while he paid particular attention to economic welfare, especially to roads. Communications were extended and improved and trade flourished.

But it was not enough for Napoleon to bring prosperity – he must also bring peace, for he had come to power on the tide not only of disgust with the Directory but of weariness with the battles which were consuming France's energies and man-power. Yet it must not be peace at any price because there were things that no Frenchman could surrender – those Revolutionary conquests like Savoy and Nice (annexed in 1792) which had antagonised Austria; and, above all, Belgium, which no British government would let him keep. This was Napoleon's dilemma. He was expected to bring peace, but the only possible peace would have lost him the support of his people and toppled him from power. So he was forced to embark on a career of conquests which began as self-defence and ended as self-indulgence. As a soldier he was, of course, not averse to war, and because he was perhaps the greatest soldier who ever lived he almost succeeded in doing the impossible – conquering Europe. But always there was Britain, secure in her island defences, ready to oppose him and pay for continental coalitions against him. Therefore Napoleon had to defeat Britain, and since his armies could not reach her he had to do it by blockade – to starve her to submission. This needed the co-operation of all Europe from Portugal to Russia. And Europe was not always willing to co-operate. So it had to be forced. And this in the end proved too great a task even for Napoleon.

A career of conquest

When Napoleon became First Consul the military situation was grave, for the right wing of the Austrian army was on the Rhine threatening a French army, under Moreau, in Switzerland. Meanwhile the Austrian left wing was at Nice besieging another French army under Masséna, in Genoa. In a fantastic campaign Napoleon marched a whole army with its full artillery across the Alps.

After taking Milan, Napoleon routed the Austrians at Marengo. Their government was forced to surrender Nice and the rest of the Riviera as well as Piedmont and Lombardy, while Genoa was recovered. At one stroke Napoleon had reversed all the Italian setbacks of the Directory.

France was thrilled and Europe was forced to look upon Napoleon, whom it had despised as a mere Corsican adventurer, with increasing admiration. His position was strengthened when, as the Austrians proved desultory at signing a peace treaty, he defeated them once more at Hohenlinden. With French troops within 50 miles of Vienna the Austrians were forced into a humiliating treaty – the Treaty of Luneville in February 1801, in which the Austrians acknowledged the surrender of Belgium, Luxemburg, and the rest of the left bank of the Rhine, French control over all Italy and a protectorate over Holland and Switzerland.

Without her Austrian ally Britain herself was forced to come to terms, and on 27th March 1802 she signed the peace treaty of Amiens with France. Napoleon's popularity soared and a referendum was issued to the French people asking whether 'Napoleon Bonaparte should be made Consul for life'. The result was an overwhelming 'yes' – 3,568,889 for and 8,374 against.

As we have said, peace was unstable while Britain was undefeated and France had Belgium. In May 1803 Britain again declared war. The mood of the next two years was desultory as Britain tried to build up coalitions on the continent, and many of the continental governments were understandably unwilling to come to grips with the mighty Napoleon quite so soon. But within France something very important happened, for following an unsuccessful assassination attempt Napoleon had himself proclaimed Emperor of France (19th May 1804) and a referendum overwhelmingly declared in favour of making the empire hereditary.

YOU SHOULD NOW KNOW

1. *When did Napoleon become Emperor of France?*
2. *Who signed the Treaty of Amiens?*
3. *Who beat whom at Austerlitz?*
4. *Joseph Bonaparte became king of which countries?*
5. *Name four battles in which the Austrians were defeated.*

issues his orders on the day of perhaps his greatest victory

On 2nd December 1804 in Notre Dame Cathedral, Napoleon was solemnly crowned in a magnificent ceremony conducted by the Pope.

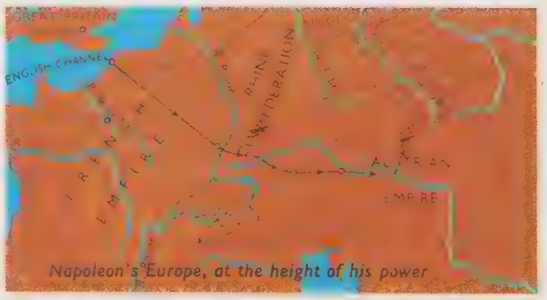
Yet Napoleon's increasing power terrified Europe. Already in possession of Holland, Piedmont, and Switzerland, on 26th May 1805 he was crowned King of Italy and prepared to invade Britain. These plans had to be abandoned for ever after Nelson destroyed his fleet at Trafalgar, but he had other matters to deal with. Britain had succeeded in bringing Austria and Russia into the field, and just before Trafalgar Napoleon once again humiliated Austria at Ulm and marched victorious into Vienna. Now it was Russia's turn, and in a brilliant campaign he took the bulk of the French army to Austerlitz where the Russians were routed together with, yet again, the Austrians. Napoleon now strode the continent like a Colossus. He abolished the title Holy Roman Empire (one more humiliation for Austria) and developed buffer states in Germany like Bavaria, Baden, and Württemberg, which would be ruled by members of his family as a pro-French check on Austria and Prussia.

Prussia was a danger. Though she allied with Napoleon and stopped trading with Britain, she broke that alliance when Britain confiscated her ships and declared war. Prussia ordered Napoleon to withdraw all his troops from Germany – a kind of insolence the French Emperor was not prepared to listen to. He marched his troops into Prussia and on 14th October 1806 shattered the Prussians at Jena. 12,000 Prussians were killed or wounded and 15,000 captured.

Despite Austerlitz, Russia was not prepared to join his projected blockade and so once more Napoleon took the field. In November 1806 he set out across Poland. After an arduous winter he finally met the Russians at Friedland and on 14th June 1807 handed out a devastating defeat. French casualties were 7,000 – Russian casualties 25,000. At the famous Tilsit meeting between Napoleon and Tsar Alexander I the Tsar agreed to join him against Britain. Now all Europe seemed at Napoleon's feet. He made his sister ruler of the Grand Duchy of Tuscany, his brother Jerome became King of Westphalia, and the Grand Duchy of Berg went to his nephew Louis Napoleon. His brother Joseph was made King of Naples and Louis became King of Holland.

Yet even after Tilsit there was not peace. The Pope would not support Napoleon's blockade and Rome was occupied; and by February 1808 he was at war with Spain. Spain, with her long coastline and dependence on trade, was showing signs of unrest at Napoleon's schemes and he determined to bring the Spanish Crown into his family circle. His troops entered Spain during a combined Franco-Spanish attack on Portugal to bring her into the blockade, and they stayed there – a powerful influence in the next act of the drama. King Charles and his son Ferdinand were in dispute over the succession. They came to Napoleon for his decision. He decided. He made them both renounce their claims and placed Joseph Bonaparte on the Spanish throne.

But the population of Spain was violently anti-French and the people fought like savages in guerrilla attacks on his men. And the Austrians were once more preparing for war. But yet again the Austrians were defeated at Wagram on 6th July 1809 and yet more Austrian territory fell to France.



Napoleon's Europe, at the height of his power

A son and heir

In April 1810 Napoleon decided it was time he himself joined one of the traditional royal families of Europe and he married a daughter of the Emperor of Austria who, after Wagram, was in no position to refuse. When, on 20th March 1811, a son, titled King of Rome, was born to them it seemed as if the most wonderful dynasty of Europe was firmly launched. Napoleon and his relatives were rulers of France, Italy, Switzerland, part of Germany, Holland, Spain, Naples, and the Grand Duchy of Warsaw. Russia, Austria, and Prussia had been defeated in battle. There only remained Britain, and surely she could not hold out for long. Never since Charlemagne had there been such a conqueror. But in our next article you can read how Napoleon's meteoric rise was checked and how his mighty empire tottered and then finally crumbled in less than half the time it took to build and conquer.

AUSTRIA: economy

GEOGRAPHICALLY, and to some extent politically, Austria stands at the crossroads between eastern and western Europe. Shorn of her once mighty empire, Austria is a small and economically not very prosperous country, land-locked between Germany, Switzerland, and Italy to the west, and Czechoslovakia, Hungary, and Yugoslavia to the east. Although Austria has no direct access to the sea, the mighty river Danube carries great quantities of coal, iron, and timber into the Black Sea.

Weaknesses and strengths

Three facets of Austria's economy stand out above all. The first is the difficulty experienced in producing enough food for the population. Agriculturally, Austria is not self-sufficient – which means that she has to buy from other countries. But unlike Britain, Austria has not yet developed her industries to the point where she can easily export manufactured goods and earn money to pay for imports.

The second feature is the undoubted potential for industrial development that exists within Austria. Already her rich mineral deposits are being used in conjunction with readily available hydroelectric power to create basic heavy industries. The economy is growing, and resources are abundant: but much remains to be done.

The third feature of Austria's economy springs from the country's great natural beauty: its mountains, lakes, forests, and historic towns. Many thousands of tourists visit Austria each year, and this provides a great source of wealth for the country.

An economic map of Austria, showing some of the major provinces

AGRICULTURE AND FORESTRY

The chief agricultural activities are dairy-farming and stock-raising. Their importance springs largely from the climatic and geographical conditions of Austria. After Switzerland, Austria is the most mountainous country in Europe, and there are large areas of forest and grazing land. One-third of the total area of Austria is meadow and pastureland, while forests cover nearly 40 per cent. Hence Austria exports not only dairy products like eggs and butter, but is one of the few European exporters of lumber and paper – the latter industries being centred in Styria. Arable land is concentrated in the regions of Upper and Lower Austria and in the Burgenland. Wheat is the main crop, followed by rye (the only cereal in which Austria is self-sufficient), barley, potatoes, and oats. Maize, sugar beet, and grapes are also cultivated widely.

cows – over 2,000,000 *horses –* 200,000 *pigs – about* 3,000,000 *sheep and goats – about* 400,000

FACTS AND FIGURES

Total population:	7,200,000
CHIEF TOWNS	
Vienna (capital):	1,700,000
Graz:	237,000
Linz:	200,000
Salzburg:	109,000
Major airports:	Vienna, Linz, Salzburg, Graz, Innsbruck
Currency:	1 schilling – 100 groschen

EFTA

Austria is a member of the European Free Trade Area, a group of seven nations which formed in 1959, under Britain's leadership, a customs union to promote free trade in industrial goods. The other members are Switzerland, Portugal, Sweden, Denmark, and Norway.

The great dam at Kaprun is 120 metres high and 357 long

ELECTRICAL ENERGY

Motive power is the key to industrial growth, and Austria is fortunate in having access to great resources of hydroelectric energy. The mountains of Austria, coupled with huge lakes and fast-flowing rivers, mean a great potential source of electricity production, and the construction of dams is proceeding rapidly.

One of the largest of these dams in the Austrian Alps is at Kaprun.

Industry

Austria is rich in mineral resources. There are vast iron-ore deposits in Styria, especially near Ergberg, and the steel industry is based on these. The major centres of the heavy iron and steel industry are in Styria – in Graz, Kapfenberg, Leoben, and Donauwitz, for example. Nearby are located the rich coal (lignite) areas, one such centre being Koflach. Copper is mined in the Tyrol, and lead, zinc, and magnesite are produced in Carinthia. Salt, too, is obtained near Hallein, and Austria is one of the world's largest sources of high-grade graphite. In addition, crude oil is produced and refined.

The availability of iron and steel has led to a great development of mechanical engineering; all kinds of locomotive engines, commercial vehicles, industrial and agricultural machinery, and precision instruments are made. Most of the high-grade finishing and processing industries are located in Vienna, or nearby centres such as Wiener Neustadt, Neunkirche, and St Pölten.

The chemical industry is highly developed, and textile production, for which Vorarlberg and Linz are especially noted, is a major industry. Agricultural processing is mainly concerned with dairy products such as butter and cheese, but Austria also grows and refines enough sugar beet for her own requirements.

The government

The government plays a major role in the Austrian economy, for many of the chief industries are nationalised – in other words owned directly by the State. These include copper, zinc, lead, and crude and refined oil production, and the manufacture of chemical fertilisers. Industries producing pig-iron, iron ore, raw and rolled steel, coal, electrical energy, and aluminium are all owned largely by the State, and some of the main banks also have been nationalised.

Tourism

Austria is a very beautiful country with a magnificent history. Each year hundreds of thousands of tourists, including skiers, visit the country, and bring prosperity to the resorts, hotels, restaurants, and numerous other branches of the economy.

Vienna, for example, with its fine historic buildings is a great tourist attraction, while the enchanting city of Salzburg, the birth-place of Mozart, holds a magnificent festival each year to which come music-lovers from all over the world.

Other areas of great beauty include the Austrian 'Lake District', the Salzkammergut in the province of Salzburg; and also the Tyrol district, some of whose inhabitants still wear the traditional native costumes.

YOU SHOULD NOW KNOW

1. *What is Austria's greatest river called?*
2. *What Austrian city is famous for its annual musical festival?*
3. *Does Austria produce enough food for her population?*
4. *Where is the centre of the Austrian iron and steel industry?*
5. *What is EFTA?*

PERICLES

IT was the year 480 B C. The vast Persian army had defeated the Greek forces in the north and was now advancing on Athens. The Athenian general, Themistocles (see page 2223), gave the order to abandon the city and led his people to safety in the nearby island of Salamis while preparing to defeat the Persians in a great sea battle. Among those who left their homes to go as refugees to Salamis was a boy of 14, a member of one of Athens's leading families. His name was Pericles and he was destined to become one of his city's greatest statesmen. How he must have longed to join the men on the ships and drive the invaders from his country! But he was too young.

As he grew up Pericles saw the Persian army driven out and peace return. He saw his own city of Athens become the leader of an empire covering the Aegean Sea and the lands around it. He saw a rival group of states headed by powerful Sparta become more and more jealous of Athens's wealth.

By the year 461 B C Pericles had become one of the most prominent supporters of the *democratic* party. When the leader of the party, Ephialtes, was mysteriously murdered, it was only natural that Pericles should take his place. On page 512 we described how in the previous century Solon and Cleisthenes created a democratic constitution for Athens. Pericles, however, introduced laws to put the government even more in the hands of the whole people. Under his laws all the officers of the state except the ten generals and all the judges in the law courts were chosen entirely by drawing lots. In addition, persons who carried out these civic duties were now paid so that even the poorest citizen was not prevented from holding office.

War and peace

By the time Pericles became a leading public figure Athens was on the brink of war. Pericles loved Athens and wanted with all his heart to make her a greater and finer city. He did not want war if it could possibly be avoided, for he knew that a war would, at that time, be as harmful to his own people as to the enemy. However in 456 B C the first of the wars between Athens and the Spartan alliance broke out. Pericles played a conspicuous part as one of the Athenian generals. In 454 (or 453) he was *strategus* (leading general) and fought in the Corinthian Gulf. The war dragged on indecisively until 451, when a treaty of peace for 30 years was agreed between Athens and Sparta. During this truce Pericles set about re-establishing Athenian authority in the empire which the war had weakened. He forced Euboea to submit, and obtained recognition of the Athenian empire from Sparta. In 440 he organised a

Bust of the statesman Pericles (493–429 B C), *who took Athens into the Peloponnesian War*

nine months' siege which compelled the island of Samos, which had rebelled against Athenian rule, to submit.

Now that Athens was not at war Pericles was able to turn his attention to something he had always wanted to do – rebuilding the city. For Athens had been destroyed by the Persians, and although, no doubt, the citizens rebuilt their houses as soon as they returned from Salamis, many of the temples and public buildings remained in ruins. Pericles determined that he would make Athens the most magnificent city in Greece. He used the taxes received from the empire to build temples and erect statues such as had never been seen before. Of all the temples the finest was the Parthenon, which was begun in 447 B C, completed in 432 and dedicated to Athena, the patron goddess of the city. You can see its ruins today, standing high up on the Acropolis hill overlooking Athens.

Pericles was too much of a statesman not to realise that the peace could not last. In fact he prepared Athens for the war he regarded as inevitable. For Pericles aimed at nothing short of complete supremacy for Athens in Greece; this meant that a final showdown with Sparta would have to come sooner or later. Pericles strengthened his country's defences while he antagonised the Spartans with his vigorous imperial policy. He established colonies at Thurii, Strymon, and Amphipolis and made alliances with several Greek states. Trade flourished in his empire and Spartan apprehension grew. In 433 Corcyra (Corfu) revolted against Corinth (a Dorian state in alliance with Sparta) and appealed to Pericles for aid. Pericles was aware of the dangers of this situation, yet under his leadership Athens allied with Corcyra and closed the Athenian empire to trade with Dorian Megara.

Pericles had thrown down the glove, and the Spartans accepted the challenge. He had the confidence of his people and when war broke out in 431 B C (the Great Peloponnesian War) it was he who planned the entire Athenian strategy. He ordered the citizens to abandon the countryside around Athens and concentrate inside the city's fortifications. He knew that the forces of Sparta and her allies were strong on land but that Athens had overwhelming sea power. Pericles's plan was to attack the enemy from the sea while fighting only a defensive action at home. The plan worked well for the first year but then a terrible plague struck Athens. Many of the Athenians died. The Athenians lost their taste for war and Pericles was deposed and fined. Yet their courage returned and in 429 Pericles was re-elected a general. But he too had been a victim of the plague and in that year he died.

The story of the rest of the war is not the story of Pericles. It ended 25 years later with the defeat of Athens, but it is more than likely that if Pericles had lived even for a few more years, Athens would have won.

YOU SHOULD NOW KNOW

1. *To which state did Pericles belong?*
2. *What was the name of the finest temple built by Pericles?*
3. *Who fought whom in the Great Peloponnesian War?*
4. *In what year did it break out?*
5. *What was Pericles's strategy in this war?*

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them. Electromagnetic waves travel best in a vacuum; that is, in the complete absence of any molecules or atoms.

The first electromagnetic waves to be investigated were light waves. Young (1773–1829) and Fresnel (1778–1827) proved that visible light was made up of waves, but they were not certain what type of waves these were. It was the famous Scottish-born scientist James Maxwell (1831–1879) who first worked out the theory of electromagnetic waves. He found that the velocity at which they should travel, according to his theory, was equal to the velocity of light, which had already been measured experimentally by the French scientist, Fizeau. So it became immediately clear that light was a form of electromagnetic wave. A few years later Heinrich Hertz (1857–1894) discovered a new type of electromagnetic wave which also obeyed Maxwell's equations, but these waves were made using a spark gap to produce rapid electrical oscillations.

The velocity of electromagnetic waves

All electromagnetic waves, including visible light, travel through space at an incredible speed, approximately 186,000 miles in one second. The velocity of these waves in a vacuum is always the same, and because it is constant it is usually given the symbol 'c'. (As in Einstein's famous equation $E = mc^2$.)

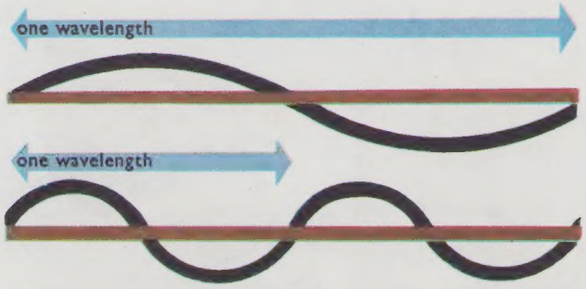
The property which distinguishes different types of waves is their *frequency*; that is, the number of waves which travel past a fixed point in one second. Frequency is measured in *cycles per second*; one cycle per second means one complete oscillation of the source of the waves in one second, or the passage of a complete wave past a fixed point in one second. The term one *kilocycle* means 1,000 cycles, and one *megacycle* means 1,000,000 cycles.

The velocity of the wave is equal to the frequency multiplied by the length of the wave, or *wavelength*. Since the velocity of all electromagnetic waves is the same in a vacuum, those of low frequency (a few cycles per second) will be long waves, whereas those of high frequency (millions of cycles per second) will be short waves.

We can find the wavelength by simply dividing the velocity (186,000 miles per second) by the frequency (cycles per second).

Radio waves:

Frequency = 93,000 cycles per second



The wavelength is inversely proportional to its frequency. Above, one complete wavelength; below, a wave with half the wavelength and double the frequency of the upper wave

$$\text{Wavelength} = \frac{186{,}000 \text{ (velocity in miles per second)}}{93{,}000 \text{ (frequency in cycles per second)}}$$

$$= 2 \text{ miles}$$

Similarly if we know the wavelength is 2 miles, then it is easy to find the frequency:

$$\text{Frequency} = \frac{186{,}000}{2} = 93{,}000 \text{ cycles per second}$$

A spectrum of 60 octaves

The family of electromagnetic waves covers a vast range of frequencies. At one end of this range are long radio waves with a frequency of about 10,000 cycles per second (a wavelength of 18·6 miles), while at the other end of the range are gamma rays with a frequency of 300,000 million million million cycles per second (a wavelength of less than one ten-millionth of a millionth of an inch). Even longer than the longest useful radio waves are the electromagnetic waves generated by the alternating electric current which bring electric power to our houses. The electrons in the wires carrying the current oscillate to and fro 50 times a second, producing waves with a wavelength of 3,720 miles (186,000 ÷ 50). This gives some idea of the enormous extent of the spectrum of electromagnetic waves.

Let us think now of two electromagnetic waves with different wavelengths, one of wavelength 20 miles and one of wavelength 10 miles. There will be a whole succession of waves whose wavelengths lie between 10 and 20 miles. The two waves we have chosen define an interval. The wave 10 miles long will, of course, have double the frequency of the wave 20 miles long.

This interval is similar to the *octave* of sound waves used in music. Everyone is familiar with the sequence doh, ray, me, fah, soh, lah, te, doh. The interval between the lower first doh and the higher second doh is called an octave. The sound wave corresponding to the second doh has half the wavelength of the first doh, and the second doh has twice as many vibrations per second as the first doh. A third doh, the next higher up the musical scale, would have twice as many vibrations per second as the second doh; and so on. So we can split up the whole range of musical sounds into octaves with the wavelength of the sound at the higher end of the octave exactly half of that at the lower end.

We can split up the whole range of electromagnetic waves into octaves in exactly the same way. The two waves we chose above, with wavelengths 10 miles and 20 miles, will enclose an octave. We need about 60 octaves to include all electromagnetic waves with wavelengths ranging from several tens of miles to less than a ten-millionth of a millionth of an inch. Radio waves take up about 11 octaves, radar about 6 octaves, X-rays 13 octaves, and gamma rays 10 octaves. The visible light which we see by takes up a very small part of the vast spectrum. The visible light region is bounded by red light with a frequency of 400 million million cycles per second, and violet light with a frequency of 800 million million cycles per second (double that of red light). Visible light therefore only takes up one octave of the 60 octaves in the electromagnetic spectrum.

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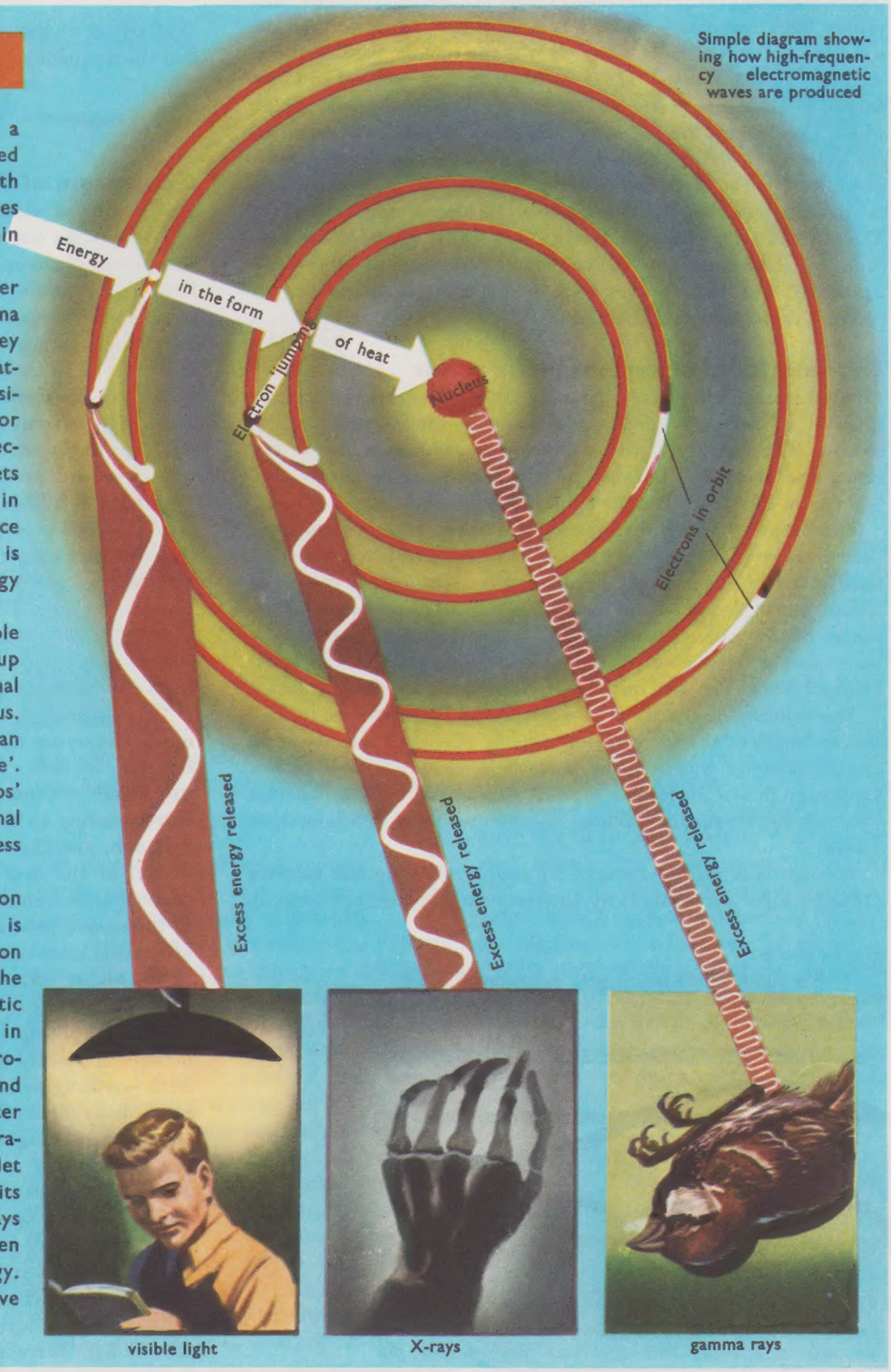
THE EMISSION OF ELECTRO-MAGNETIC WAVES

Electromagnetic waves of wavelength from a few inches up to many miles can be generated by setting electrons surging back and forth in a wire, the *aerial*. The number of times they swing back and forth can be altered in various ways.

Electromagnetic waves with far shorter wavelengths, such as light, X-rays, and gamma rays, are not produced in this way. They originate in the atoms which make up all matter. Every atom consists of a central positively charged nucleus surrounded by one or more negatively charged electrons. The electrons travel round the nucleus like planets round the sun. Each electron goes around in its own orbit at a definite average distance from the nucleus. The further the orbit is from the nucleus, the greater is the energy possessed by the electron.

When an atom receives energy (for example in the form of heat) the electrons take up this energy and may 'jump' from their normal orbit into one further from the nucleus. The electron has now got more energy than normal and is said to be in an 'excited state'. In a very short time the electron 'jumps' back from its excited orbit to its normal orbit. As it does so it gives up its excess energy as electromagnetic waves.

The closer the normal orbit of the electron is to the nucleus of the atom, the greater is the energy given up when an excited electron 'jumps' back to its normal orbit and the higher is the frequency of the electromagnetic wave which it emits. Therefore electrons in orbits very close to the nucleus emit electromagnetic waves of shorter wavelength and higher frequency than those in the outer orbits. The outermost electrons emit infra-red waves, visible light waves, and ultra-violet waves, whereas those in the innermost orbits emit X-rays when they 'jump'. Gamma rays are produced in the nucleus of an atom when it is 'excited' and rids itself of excess energy. They are frequently emitted by radioactive substances.



Simple diagram showing how high-frequency electromagnetic waves are produced